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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of the Commission's	)	GEN Docket No. 90-314
Rules to Establish New Personal	)	ET Docket No. 92-100
Communications Services	)	

COMMENTS OF PACIFIC COMMUNICATION SCIENCES, INC.

Pacific Communication Sciences, Inc. ("PCSI") submits these comments in response to the Notice of Proposed Rulemaking ("Notice") herein.[1]

Summary of Position

The FCC should take into account the technical standards that are evolving for Digital European Cordless Telephone (DECT) and Japan's Personal Handy Phone (PHP) when adopting standards for PCS. The

[1]FCC 92-333, released August 14, 1992.

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FCC should not preclude DECT/PHP technologies from being used in the U.S. for PCS. The U.S. public can benefit from economies of scale that are more quickly achievable through worldwide supply of a common technology to a worldwide market.

It is PCSI's opinion that time division duplex (TDD) is the technology likely to be the best choice for certain U.S. personal communications applications. Because TDD does not need separated frequency bands for the base-to-handset and handset-to-base paths, a major cost reduction is achieved by the elimination of hybrids, duplexers and filters in the handset. Another advantage is that the handset-to-base path is perfectly identical to the base-to-handset path, and this translates into cost reductions as well.

There are substantial public benefits from allowing the same technologies for use in both licensed and unlicensed PCN applications. These include cost advantages due to economies of scale, and convenience benefits through the use of dual-service handsets.

The PCS channel plan for licensed operations should be contiguous, not split into separate bands for base-to-handset and handset-to-base operations.

Specific changes are needed in the proposed Part 15 channel plans and power limits to make them more flexible and consistent with the plans for DECT and PHP, so that these technologies can be used for unlicensed operations in the U.S. In addition, more spectrum is needed for unlicensed wireless PBX applications; 5 MHz of additional spectrum should be allocated for such unlicensed operations.

PCSI's Interest in this Proceeding

PCSI, since its beginning in April 1987, has established an international reputation for communications systems engineering, speech compression algorithm development, digital signal processing and microwave integrated circuit design for mobile and personal communications.[2] Over 30% of PCSI's business is international, with significant exports to Japan. A large portion of PCSI's exports to Japan are subsystems that are integrated into communications products that are destined for use in the United States.

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[2]The Commission recently granted PCSI an experimental license KM2XKO for development and testing of an integrated chip set for a wireless communications system operating in the 1900 MHz range.

For over two years, PCSI has had a major effort ongoing to develop critical chip level technologies for worldwide personal communications services. Highly integrated custom chips and monolithic microwave integrated circuit (MMIC) devices are being designed for emerging PCS world standards including potential applications to the Digital European Cordless Telephone (DECT)[3] and Personal Handy Phone (PHP) in Japan.[4]

PCSI develops and produces highly integrated, low power components and subsystems that are inexpensive partly due to design methods and partly due to high volume of production. Because of work now underway at PCSI, including field testing in San Diego under PCSI's experimental license, such integrated chip sets can be in high volume production by the end of 1993.

PCSI operates in partnership with other system design houses and chip foundries. PCSI's current partners are U.S.-resident compa-

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[3]The Commission is familiar with DECT; see Notice at footnote 108.
[4]PHP is an emerging personal communications service planned for the 1900 MHz range. NTT released a public procurement document in December 1990 with applications and technical approaches similar to PHP. An invitation to participate in a PHP field test was dated August 6, 1991. Initial field tests were carried out in Japan in April and May, 1992. The PHP standard is soon to be released as document RCR Standard 28.

nies and all chip foundries are located in the U.S. U.S. companies, including PCSI and its partners, have become and will continue to be significant suppliers of components and subsystems to overseas manufacturers for worldwide markets. The FCC should not adopt regulations that preclude the incorporation or adaptation of these technologies for use in United States personal communications systems.

FCC Standards Should Be Compatible With Relevant Foreign Standards

The FCC should take into account the technical standards that are evolving for DECT and PHP when adopting standards for PCS. The FCC should not preclude DECT/PHP technologies from being used in the U.S. for PCS.

As noted above, U.S. companies are and will be supplying components and subsystems for DECT and PHP. The U.S. companies should be permitted to enter the U.S. market with these technologies.

The DECT and PHP technologies are intended to and can support residential, wireless office and public pedestrian personal communications services in a cost effective manner. The DECT and PHP sys-

tems employ time division multiple access (TDMA) time division duplex (TDD) operation on each radio channel. In fact, as discussed more fully below, PCSI believes that TDD technology has the best chance of resulting in consumer transceivers in the $200 retail price range in 1994.

The U.S. public can benefit from economies of scale that are more quickly achievable through worldwide supply of a common technology to a worldwide market. By taking into account personal communications developments in Europe and Japan, and by assuring that common technologies are not precluded in the U.S., the FCC can promote benefits both for the U.S. public and for U.S. companies that participate in worldwide markets.

Time Division Duplex Technology Is Likely To Be The Best Choice For Certain U.S. Personal Communications

It is PCSI's opinion that TDD is the technology likely to be the best choice for certain U.S. personal communications applications. Both DECT and PHP will employ TDD[5]. The two alternative technologies, TDMA as it is embodied in the U.S. cellular standard IS54, and CDMA, need separated frequency bands for the base-to-handset and handset-to-base paths and are likely to be much more expensive.

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[5]TDD uses the same radio channel for two way communications between

Because TDD does not need separated frequency bands for the base-to-handset and handset-to-base paths, a major cost reduction is achieved by the elimination of hybrids, duplexers and filters in the handset. Another advantage is that the handset-to-base path is perfectly identical to the base-to-handset path, and this translates into cost reductions as well.

Traditional mobile communications uses separate frequency bands for the base-to-handset and handset-to-base paths. For analog voice systems, such a design is essential. Even for digital systems, this frequency separation simplifies the design of radio equipment, but it imposes additional costs. It requires additional filters, duplexers and frequency sources (local oscillators).

For example, if two RF dielectric filters are needed in a handset instead of one, to accommodate separate transmit and receive fre-

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base and handset, while more traditional mobile communications systems such as the cellular IS54 and CDMA use different radio channels for base-to-mobile and mobile-to-base communications. The TDD design we support is also a TDMA design, since it allocates time slots among users.

quency bands, this will increase the component cost and will also increase the size, weight and power consumption of the handset. If a single frequency-synthesized local oscillator is used for both the (separated) transmit and receive frequencies, then the tuning range is greater than would be needed for TDD and thus the cost is higher.

Multipath interference is likely to be a technical challenge for personal communications systems operating at 1900 MHz, particularly for wireless PBXs and other indoor communications.[6] TDD provides an advantage in combatting multipath because the base-to-handset and handset-to-base path operate on the same frequency, and thus the paths are identical. As a result, antenna diversity to combat multipath[7] need only be employed in the base station, not in the handset.

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[6]PCSI believes that the multipath-mitigation advantages of CDMA disappear in slow-movement and fixed applications such as public pedestrian service, wireless PBX and residential cordless telephony.

[7]Antenna diversity is the least expensive way to eliminate multipath interference. This consists of two antennas, typically separated by a fraction of a wavelength or more, and a logic network to choose the best signal from the two. In a communications system with separate frequencies, the antenna diversity is implemented at the receive end of each path, so two antennas would be needed at each end. In a TDD system using the same frequency for both directions, two antennas are needed only at the base station; because of the radio principle known as reciprocity, the antenna selected at the base station for the best multipath rejection in reception is also the best choice for transmission.

Based on our experience as a supplier of baseband subsystems for cellular telephony, we believe that cellular TDMA IS54 portable telephones could have a parts cost of 2 to 3 times the cost of a DECT or PHP handset using TDD. CDMA portables could be even more expensive, based on the designs that some have proposed.

TDD is likely to make more efficient use of the radio spectrum, particularly for services or communications requirements that are asymmetric in duration and demand. In traditional two-way communications systems, the same size channel is used for the base-to-handset and handset-to-base communications. With TDD, it is easier to allocate capacity on a single channel to the two directions according to need. With separate transmit and receive frequencies, however, it is far more difficult to allocate capacity asymmetrically.

In summary, TDD is likely to be both the least expensive approach for personal communications and highly efficient in spectrum utilization.

Same Technologies Should Be Usable For Both Licensed And Unlicensed PCN Services

There are substantial public benefits from allowing the same technologies for use in both licensed and unlicensed PCN applications. These include cost advantages due to economies of scale, and convenience benefits through the use of dual-service handsets.

We envision a person using the same handset with a wireless PBX in an office, with a public telepoint-like terminal as a pedestrian, and with a residential cordless telephone base station at home. We envision a network environment that supports a single telephone number to identify this handset as it moves from one service environment to another. But we do not envision the use of a variety of technologies in going from one service environment to another, because multiple-technology portable handsets will be too expensive and too heavy to be attractive in the marketplace.

The Commission has proposed specific regulations and technical standards under Part 15 for unlicensed operation of wireless PBXs and LANs, and cordless residential telephony, but it has not pro-

posed any comparable standards for licensed operations. We are concerned that this is likely to lead to different, incompatible technologies developing for licensed and unlicensed operations.

The Commission has proposed Part 15 regulations for unlicensed PCN use that envisions a contiguous band of spectrum, rather than the use of transmit and receive frequencies that are separated. We support this approach[8], and oppose the plan for separated transmit and receive frequencies proposed for the licensed frequencies.

We specifically ask the Commission to incorporate enough flexibility into both its Part 15 regulations for unlicensed operation and whatever technical regulations are adopted for licensed services to permit the same equipment and technologies to be used for both.

Contiguous Bands Rather Than Split Bands Should Be Assigned To Each Licensee

The PCS channel plan for licensed operations should be contiguous, not split into separate bands for base-to-handset and handset-to-

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[8]We suggest specific changes to these proposals below.

base operations. The Commission's proposed channel plan[9] is incompatible with the TDD technology[10] that will be employed in DECT and PHP, and it will impose additional costs on the public.

We propose two alternative channel plans that employ contiguous blocks of frequency. The first channel plan maintains the total amount of spectrum of 30 MHz per licensee:

Block A	1850-1880 MHz
Block B	1880-1910 MHz
Block C	1935-1965 MHz[11]

The second channel plan reflects our view that 20 MHz per licensee

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[9]Notice, para. 38.

[10]We also call attention to the inconsistency between the Commission's statement of intent in paragraph 38 of the Notice and proposed rule Section 99.405. The Commission states in para. 38 that the proposed channel plan will permit the use of time division duplex technology. However, Section 99.405 specifically designates the lower frequencies (1850-1895 MHz) for base stations and the higher (1930-1975 MHz) for mobile/portable stations. This would appear to prohibit TDD, which uses the same frequencies for both base and portable stations. Should the Commission decline to accept our proposal for contiguous band assignments, then we ask that the base and mobile/portable designations be eliminated from the rules.

[11]This channel plan also reflects our opinion that an additional 5 MHz is needed for unlicensed operations, as discussed below.

should be sufficient to satisfy demand:[12]

Block A	1870-1890 MHz
Block B	1890-1910 MHz
Block C	1935-1955 MHz
Block D	1955-1975 MHz.

The channel plan proposed by the Commission for licensed operation, with split frequency blocks, is inconsistent with the channelization proposed for Part 15 unlicensed operation, and this inconsistency will lead to unnecessary costs and consumer inconvenience. It is a barrier to the use of the same technologies for licensed and unlicensed use. A contiguous channel plan would increase the likelihood that the same technologies can be used for both service environments.

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[12]PCSI has performed a number of traffic engineering studies to estimate the amount of spectrum needed for personal communications services. A heavy traffic case would consist of 20,000 erlangs/km^2 of offered traffic. This translates into 2 active calls per 10 meter by 10 meter square. Our model calculates that in order to avoid co-channel interference, 128 channels are needed to support this traffic load. Taking into account adjacent channel interference raises this to 192 channels. For the PHP design, which carries 4 two-way conversations per 300 kHz channel, this translates into 15 MHz of spectrum. This is based on today's 32 kbit/sec voice coding techniques; lower data rate voice coding will become more economical over time.

A contiguous channel plan is consistent with the plans for DECT and PHP. As such, it will lead to consumer cost benefits because the DECT and PHP technologies can be incorporated into U.S. products. And as we have previously stated, U.S. manufacturers such as PCSI will benefit since they are already participating in these overseas markets.

The Proposed Technical Rules For Unlicensed Part 15 Equipment Should Be Modified

The proposed Part 15 regulations provide a good start toward the development of a unlicensed service environment for PCS. However, we propose specific changes in the amount of spectrum, channel plans and power limits to make the Part 15 rules more flexible and consistent with the plans for DECT and PHP. In this way, those technologies can be quickly implemented in the U.S. environment.

The Commission has proposed to divide up the 1910-1930 MHz band as follows:

frequency	channel size	power density
1910-1920	2 to 10 MHz	0.5 mW/kHz
1920-1925	100 kHz	0.2 mW/kHz
1925-1930	1.25 MHz	0.08 mW/kHz

We believe that the power density proposed for the 1910-1920 MHz band is too high, and could be cut nearly in half to 0.27 mW/kHz. We understand that this band is likely to be used for data LANs and other wideband spread spectrum systems. This lower power density would still permit the proposed output power limit of 1 watt across the entire 10 MHz band, and it would decrease interference between different users in adjacent offices and adjacent floors of office buildings. Also, this proposed power density is consistent with the level we suggest, below, for the rest of the unlicensed spectrum. Consequently, we proposed that Section 15.253(b)(1)(iv) be modified to 0.75 mW in any 3 kHz.

Narrower Bandwidth Operations: Preferred Approach

We believe that the 10 MHz of spectrum intended for narrower bandwidth operations (1920-1930 MHz) is not sufficient to satisfy wireless PBX demand requirements using voice coding technology that is economically available in the near term. Our traffic analysis cited above indicates that 15 MHz will be needed to satisfy demand in many office environments. Consequently, we propose that 1920-1935 MHz be made available for such use.[13]

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[13]While more complex voice coding than 32 kbit/sec ADPCM will be

Next, we believe that the separation of this band into different blocks for different bandwidth systems is inefficient. The entire band (preferably 1920-1935 MHz, but otherwise 1920-1930 MHz) should be channelized into 100 kHz subchannels, and the use of multiple subchannels should be permitted.[14]

This approach will provide the flexibility to support technologies that are employed for licensed operations, as well as those that are intended solely for unlicensed use. It can support overseas technologies such as PHP with a 300 kHz bandwidth and DECT with a 1.728 MHz bandwidth.

Even apart from incompatibility with PHP, a 100 kHz channel bandwidth is unsatisfactory for more general reasons. It is too small to be efficient and would limit the evolution to more advanced technologies. It would support only a single two-way voice communication connection per 100 kHz channel, when employing a low cost

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available in the longer term, and would reduce the spectrum requirement, in the near term 32 kbit/sec provides the best cost/quality solution.

[14]This is the approach used by the Commission for Aural Broadcast Auxiliary Microwave spectrum, for example; see Section 74.502(b).

voice coding technology such as 32 kbit/sec ADPCM. A 100 kHz channel would not be compatible with any flexible TDMA/TDD design because it cannot support the multiple time slots that are inherent in TDMA design. Moreover, in a TDD system it could not support a 64 kbit/sec or 144 kbit/sec digital channel that might be part of an ISDN service, whereas a TDMA/TDD system with a wider channel such as PHP or DECT could support such a requirement.

With our approach, which allows multiples of 100 kHz to be used according to the design of the system, an office on one floor of a building can use a wireless PBX that employs PHP technology, while an office on the next floor can use DECT technology. To the extent that frequency sharing protocols are needed to minimize interference when systems of different bandwidth are used near one another, we believe that they will be developed under the auspices of appropriate industry groups such as TIA.

If this approach is adopted, then the power density for this band should be set at 0.27 mW/kHz. This would satisfy the planned PHP standard of 80 mW in a 300 kHz channel, and is only slightly higher than the 0.2 mW/kHz proposed for the 100 kHz channels in Section 15.253(b)(2).

Narrower Bandwidth Operations: Alternate Approach

If the Commission decides not to adopt our flexibility proposal to permit multiples of a basic 100 kHz subchannel in the 1920-1935 MHz or 1920-1930 MHz band, then we request that Section 15.253 be modified to explicitly include the PHP and DECT channels sizes and power levels. As that section is now proposed, these two overseas systems would be precluded from use as unlicensed systems in the U.S.

PHP operates with a channel of 300 kHz, and an output power of 80 mW. There does not appear to be any reason for the 100 kHz channels proposed for the 1920-1925 MHz band. Section 15.253(b)(2) should therefore be revised either to change the 100 kHz channel width to 300 kHz, or to permit the operation on multiples of a basic 100 kHz channel, rather than limited to a single 100 kHz channel as it now reads.

Section 15.253(b)(2) should also be revised to allow a peak power of 80 mW in 300 kHz, or 27 mW per 100 kHz. This is only a small increase over the current proposal of 20 mW per 100 kHz.

DECT operates with a channel of 1.728 MHz, and an output power of 250 mW. Section 15.253(b)(3) should be modified so that it can accommodate three DECT channels. This requires a total bandwidth

of 5.184 MHz. We propose that the spectrum 1925-1930.184 MHz be specified for this purpose. There does not appear to be any reason for the 1.25 MHz channels proposed for the 1925-1930 MHz band. Section 15.253(b)(3)(i) should be modified to specify a channel size of 1.728 MHz, and Section 15.253(b)(3)(ii) should specify a peak output power of 250 mW per 1.728 MHz, or 0.15 mW/kHz.

Conclusion

PCSI recommends that the FCC adopt policies and rules that make it possible for the U.S. public to benefit from personal communications developments in other countries. The public will benefit because worldwide economies of scale will be achieved sooner than national economies of scale, and the higher production volumes will result in lower equipment cost to the public. The specific technologies being promoted in Europe and Japan--time division duplex coupled with time division multiple access--have a number of inherent advantages for wireless office PBX, residential cordless telephone and pedestrian service environments. These technologies should be permissible for both licensed and unlicensed personal communications systems.

U.S. manufacturers who intend to be worldwide suppliers will benefit if the TDMA/TDD technologies they are supplying for overseas use are also available in this country. With the extraordinary degree of integration now achievable at the component level, U.S.

manufacturers of personal communications equipment should be able to compete with any company in the world, providing there is sufficient commonality in equipment standards.

Respectfully submitted,

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November 9, 1992